CLAIMS

What is claimed is:

1. In an implantable medical device for implant within a patient, a method comprising:

detecting a plurality of ventricular repolarization events within cardiac signals;

determining energy values associated with the plurality of ventricular repolarization events; and

detecting cardiac ischemia based on the energy values of the ventricular repolarization events.

2. The method of claim 1 further comprising determining maximum slopes of the ventricular repolarization events and wherein detecting cardiac ischemia based on energy values comprises utilizing the maximum slopes of the ventricular repolarization events.

3. The method of claim 1 wherein detecting a plurality of ventricular repolarization events comprises discarding repolarization events associated with one of fusion beats and ectopic beats.

4. The method of claim 1 wherein detecting ventricular repolarization events comprises:

sensing bipolar signals using a bipolar lead mounted within the atria and detecting atrial events therein;

sensing unipolar signals using a unipolar lead mounted within the heart, the unipolar signals having potentially both atrial and ventricular events therein;

eliminating the atrial events from the unipolar signals to leave substantially only ventricular events therein; and

examining the ventricular events remaining within the remaining unipolar signals to identify repolarization events.

5. The method of claim 1 wherein detecting ventricular repolarization events comprises:

identifying peaks of the ventricular repolarization events; and

specifying repolarization windows based on the repolarization event peaks.

6. The method of claim 5 wherein specifying repolarization windows based on the repolarization event peaks comprises:

identifying a starting point of the repolarization window as commencing 150 milliseconds (ms) prior to a repolarization event peak; and

identifying an ending point of the repolarization window as terminating 150 ms after the repolarization event peak.

7. The method of claim 1 wherein detecting ventricular repolarization events comprises:

identifying peaks of the ventricular depolarization events; and

specifying repolarization windows based on the depolarization event peaks.

8. The method of claim 7 wherein specifying repolarization windows based on the depolarization event peaks comprises:

identifying a starting point of the repolarization window as commencing 80 milliseconds (ms) after the depolarization event peak; and

identifying an ending point of the repolarization event window as terminating 480 ms after the depolarization event peak.

9. The method of claim 1 wherein determining energy values associated with the plurality of ventricular repolarization events comprises calculating:

$$E_{T-Wave} = \sum_{n=Tstart}^{Tend} s(n)$$

wherein s(n) is a digitized version of the cardiac signal, T_{start} and T_{end} are start and end points, respectively, of the repolarization event, and n represents individual samples of the digitized version of the cardiac signal.

10. The method of claim 1 further comprising detecting a ventricular depolarization event within the cardiac signals that corresponds to the repolarization event;

determining whether the ventricular repolarization event was the result of a paced beat or a sinus beat; and

wherein the step of detecting cardiac ischemia based on the energy values of the repolarization events takes into account whether the ventricular repolarization events are the result of a paced beat or a sinus beat.

11. The method of claim 10 wherein, in response to a sinus beat, detecting cardiac ischemia comprises:

determining a peak amplitude of the depolarization event that corresponds to the repolarization event;

normalizing the energy values of the repolarization events based on the peak amplitude of the corresponding depolarization event;

determining a running average of normalized energy values of all sinus repolarization events;

calculating a difference between a current repolarization event energy value and the sinus event running average; and

determining whether the difference exceeds a predetermined sinus beat threshold.

12. The method of claim 11 wherein, in response to a sensed beat, detecting cardiac ischemia comprises:

determining whether the sensed beat is an ectopic beat and, if so, ignoring the repolarization event associated with the ectopic beat in the detection of cardiac ischemia.

13. The method of claim 10 wherein, in response to a paced event, detecting cardiac ischemia comprises:

determining a measure of evoked response for the depolarization event that corresponds to the repolarization event;

normalizing the energy values of the repolarization events based on the evoked response of the corresponding depolarization event;

determining a running average of normalized energy values of paced repolarization events;

calculating a difference between a current paced repolarization event energy value and the paced event running average; and

determining whether the difference exceeds a predetermined paced beat threshold.

14. The method of claim 13 wherein, in response to a paced event, detecting cardiac ischemia comprises:

determining whether the paced beat is a fused beat and, if so, ignoring the repolarization event associated with the fused beat in the detection of cardiac ischemia.

15. The method of claim 1 further comprising:

generating a warning signal indicative of the onset of ischemia.

16. The method of claim 15 wherein the warning signal is an internal warning signal applied directly to patient tissue and has a stimulation frequency different from any other warning signal generated by the device.

17. In an implantable medical device for implant within a patient, a system comprising:

a T-wave detection subsystem;

a T-wave energy integration subsystem operative to detect a total energy associated with individual T-waves; and

a cardiac ischemia detection subsystem operative to detect cardiac ischemia based on the total energy of the individual T-waves.

18. The system of claim 17 further comprising a T-wave slope determination subsystem operative to determine a maximum slope of individual T-waves and wherein the cardiac ischemia detection subsystem is further operative to exploit the maximum slope of individual T-waves in detecting cardiac ischemia.

19. The system of claim 17 further including a cardiac ischemia warning system.

20. The system of claim 17 wherein the cardiac ischemia detection subsystem includes:

a paced beat unit operative to detect cardiac ischemia based on total energies of T-waves arising from paced ventricular beats; and

a sinus beat unit operative to detect cardiac ischemia based on total energies of T-waves arising from sinus ventricular beats.

21. In an implantable medical device for implant within a patient, a system comprising:

means for detecting a plurality of ventricular repolarization events within cardiac signals;

means for determining energy values associated with the plurality of ventricular repolarization events;

means for detecting cardiac ischemia based on the energy values of the ventricular repolarization events; and

means for generating a warning signal indicative of cardiac ischemia.